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LOCAL AND MIGRATORY MOVEMENTS OF RADIO-TAGGED JUVENILE HARRIERS

by

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Abstract

To determine post-fledging movements of the juvenile Northern Harrier (*Circus cyaneus*) hatched on the Buena Vista Marsh, central Wisconsin, I radio-tagged both adult and nestling harriers. I followed the local movements of 7 radio-tagged juveniles from 3 nests, 1 nest in 1976 and 2 in 1977, and the early migratory movements of 3 of these juveniles in 1977. All 7 remained within 1.4 km of their nests for about 3 weeks after their first flights. They did little if any hunting during this period. Five of the 7 left the study area between 20 and 23 days after fledging. One juvenile was killed near its nest by a predator 32 days after fledging, and the last one left the study area 50–51 days after fledging.

I obtained information on 4 of the 6 juveniles that left the study area. All 4 left alone, rather than with parents or siblings. Three were located during migration. Their migratory movements were interrupted by the establishment of temporary home ranges that were used for 2–3 weeks. One juvenile was located once 71 km southeast of her nest. Another was monitored in two temporary home ranges, one 85 km east-southeast and another 171 km southeast of his nest. A third juvenile was tracked continuously until she was in a temporary home range 164 km southeast of her nest. All known locations of the migrating juveniles were in the southeast quarter of Wisconsin. Case histories of the movements of these 3 juveniles are presented in detail.

Introduction

Several long-term investigations have been conducted on *C. cyaneus* (Balfour 1957, 1962, 1963, 1968; Balfour and Cadbury 1975; Watson 1977; and Hamerstrom 1969, 1979). Very little, however, is known about the post-fledging period of the harrier breeding cycle. Fisher (1893), without giving any evidence, stated that "After the young are reared and leave the nest they remain together, and as fall advances several families

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unite and migrate southward." Beebe (1974) stated that fledged young harriers associate with their parents for about 3 weeks; Breckenridge (1935) thought that the family group broke up when the young were about 8 weeks of age. Previous dispersal data (Hammond and Henry 1949, Watson 1977) have been based only on banding returns and suggest that a combination of migration and random dispersal occurs after the nesting season.

These fragmentary statements clearly show a need for a study of post-fledging movements of juveniles. My purpose was to determine movements of juvenile harriers around their nests and pattern of dispersal from the study area. Because this is the first study of dispersing juvenile harriers, their case histories are described in detail.

The juveniles were hatched on the Buena Vista Marsh, Portage County, Wisconsin during 1976 and 1977. The study area has been described by Hamerstrom et al. (1957). The juveniles were found and tracked in the southeast quarter of Wisconsin after leaving the Buena Vista Marsh.

Methods

The juvenile harriers were radio-tagged with crossed-loop backpacks, described by Beske (1978), at 30-35 days of age, just before they were capable of sustained flight. Life expectancies of the radio-packages ranged from 333-400 days.

The juveniles were also individually color-marked by bleaching 4 adjacent primaries, secondaries, or rectrices as described by Ellis and Ellis (1975).

I used a 1972 Volkswagen bus outfitted with a Hy-Gain Model 28 antenna (Hy-Gain Electronics Corp., Lincoln, Nebraska) that could be rotated from inside the vehicle and an LA 12 receiver (AVM Instrument Co., Champaign, Illinois) for ground tracking. When ground contact was lost, I searched for the signal with a Cessna 150 or similar aircraft, to which Cush Craft A147-4 4-element yagi antennas (Cush Craft, Manchester, New Hampshire) were attached to both wing struts. A switch box connected to the antennas allowed me to search on either side of the aircraft. I flew straight line transects at 19.3 km intervals at altitudes of 762-1067 m above ground level until I received the signal. Then I circled the signal at lower altitudes, 90-150 m, to determine the bird's exact location.

On 24 July 1976 I radio-tagged and color-marked the 2 oldest juveniles, both males, at a nest of four. I also color-marked the other 2 young, a male and female, and the 2 adults. I monitored the radio-tagged birds daily until 13 August and recorded 32 locations for each. Studies in 1976 were limited to local movements.

In 1977 I radio-tagged and color-marked all 3 juveniles at 1 nest. One female (hereafter referred to as F1) was tagged on 21 July and the other two young, a male (M1) and a female (F2), were radio-tagged and color-marked the next day. At another nest 2 juveniles, a male (M2) and a female (F2), were radio-tagged and color-marked on 21 July; a female nestmate was flying too well to be captured. I estimated hatch date of the oldest bird at each nest to be about 18 June, by using an age scale based on measurements of the longest remex, a modification of an age scale by Scharf and Balfour (1971). Harriers do not leave the nest abruptly but move in and out over a period of days; they leave before they are capable of sustained flight. Fledging date is thus difficult to define. The date of radio-tagging can be considered as the fledging date for these birds.

I recorded 115 locations of the 5 radio-tagged juveniles through 11 August. These radio locations were supplemented by visual observations whenever the birds were visible. Observation times ranged from 5 to 60 min and were distributed throughout the daylight hours.

Movements around the nest were recorded on acetate overlaid on aerial photographs. After the juveniles dispersed from the study area I followed individual birds for periods of 3-5 days from 13 August to 21 October and recorded their movements on county highway maps.

A compensating polar planimeter was used to measure areas.

Results

Local Movements

The 2 juveniles radio-tagged in 1976 remained near their nest from 24 July until 13 August. On 16 August I could locate neither of the tagged young, their color-marked

siblings, nor either adult. Apparently the whole family left the area on 14 or 15 August. I checked the nest site and surrounding 23.3 km² periodically for the next 3 days but never picked up a signal or saw any of the marked birds again. I do not know if the family group left together. The juveniles had been flying for about 20 days when they left. I made no attempt to locate them off the study area.

The young stayed near the nest until they disappeared. All radio-locations were within 0.6 km of the nest and the radio-tagged young were always found within 180 m of each other.

I saw very little activity during the immediate post-fledging period. From 24 July through 2 August tagged and untagged juveniles made short flights around the nest, but spent most of the time out of sight on the ground. By 3 August they perched on small shrubs although their landing attempts were still quite clumsy.

The oldest radio-tagged juvenile unsuccessfully chased a small passerine for about 28 m on 7 August. This was the only definite hunting behavior I saw before dispersal.

All three juveniles (F1, F3, and M1) at one 1977 nest remained within 1.4 km of their nest from 21 July until 11 August. These 3 birds used an area of 56 ha during the post-fledging period (Fig. 1). M1 left the study area on 11 August, 20 days after fledging, and F1 left the next day. F3 remained near the nest for 50 days after fledging and left on 10 or 11 September.

The two juveniles (F2 and M2) at the other nest remained within 1.0 km of their nest and used an area of 49 ha. F2 left the study area on 13 August, 23 days after fledging. M2 remained near his nest for 32 days after fledging. I found him freshly killed, apparently by a Great Horned Owl (*Bubo virginianus*), in his night roost 0.6 km from his nest on 22 August.

The juveniles at both nests were always located within 180 m of their siblings. Although they often chased and followed each other, I never saw any of them follow their parents on hunting forays. The adults at both nests, all radio-tagged or color-marked, spent very little time within the range of the young during the post-fledging period, visiting it only when bringing prey to them, to defend against intruders, or for very short periods of perching or preening. The young usually became inactive if the adults detected me, but my presence did not seem to affect them when adults were not nearby.

Again in 1977 I saw no prey taken by the juveniles before they left the study area.

Migratory Movements

Dispersal of the radio-tagged young harriers at the onset of migration can best be described as a slow, generally southeasterly movement interrupted by pauses at temporary home ranges. I define a temporary home range as an area used by a bird for a period of several days. I have divided movements into three main types: 1) Permanent moves are one-way flights from a night roost or temporary home range to another without going back. 2) Exploratory flights are flights from a temporary home range and back (two-way flights). 3) Home range movements are flights that were repeated during a period of several days in a limited area.

Of the 5 juveniles radio-tagged in 1977, 1 (M2) was killed before migrating, and 1 (F3) left 50 or 51 days after fledging and was not seen again. Three, M1, F1, and F2, dispersed from the study area 20, 22, and 23 days respectively after fledging. I located all 3 off of the study area; their dispersal is discussed below.

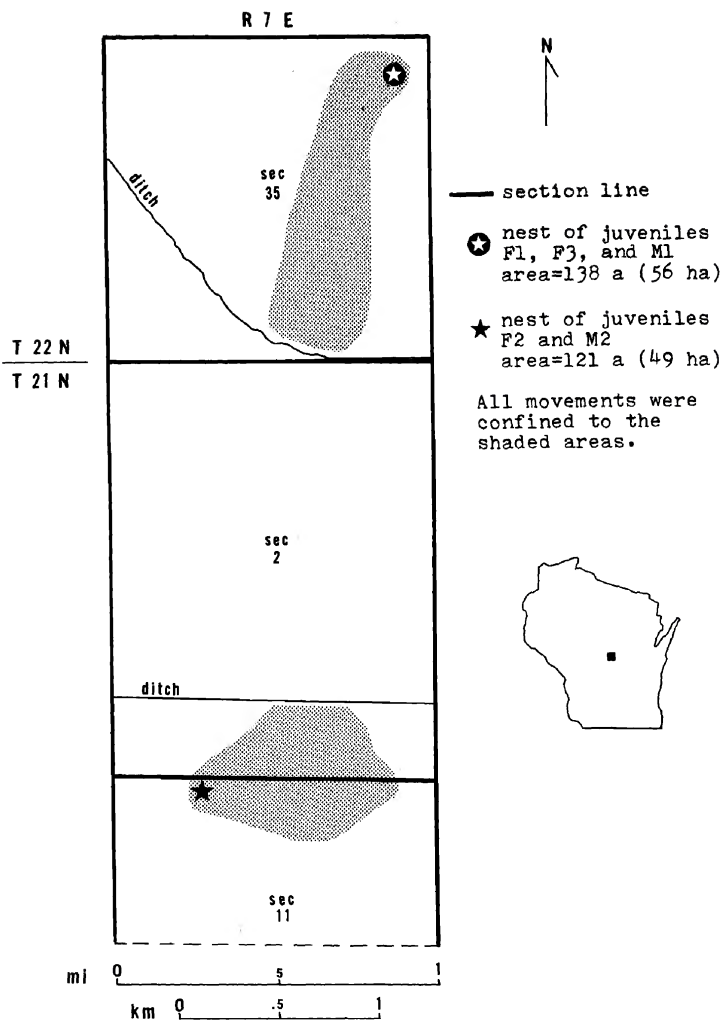


Figure 1.—Local movements of five radio-tagged juvenile harriers around two nests in 1977 on the Buena Vista Marsh, Wisconsin.

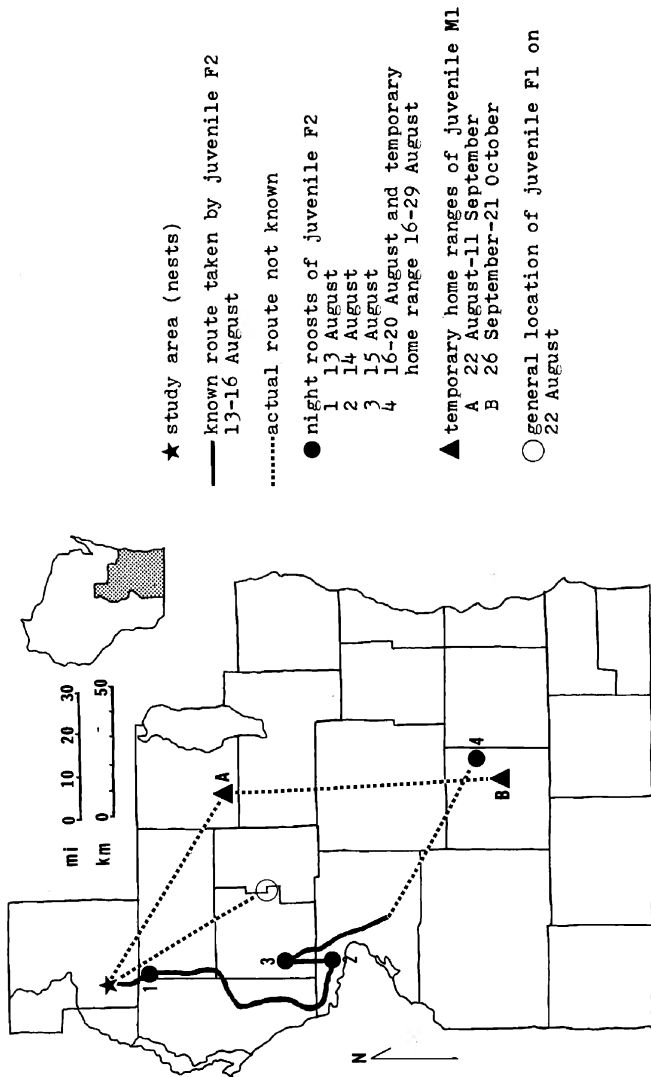


Figure 2.—Overall migratory movements and locations of roosts and temporary home ranges of three juvenile harriers: 11 August-21 October 1977.

Case history of F2: F2 remained within 1.0 km of her nest until 13 August. At 1500 (Central Standard Time) that day she started soaring and began moving south. She soared south about 14.5 km during the next hour and then quit soaring and began wandering through several sections of land during the next 2 hours. By 1800 she had perched in a plantation of 4.3 m high red pines (*Pinus resinosa*) and remained there until dark (roost 1, Fig. 2).

The next morning F2 flew out of this unusual roost (unusual because harriers do not normally frequent dense woods) at 0503, began flying southeasterly, turned south. By 1000 she was 12.9 km south of the roost. A northwest wind had gradually come up and at 1009 F2 began soaring. She rose quickly to an estimated 213–244 m and started moving more quickly to the south. She soared for 9.7 km and then moved southwesterly for 16 km. Then she turned south again for 30.9 km. At 1154 I lost radio signal. I located her again at 1259. She had quit soaring and was hunting. By 1310 she began soaring again, although only rising to about 30 m and continued south. She moved 5.6 km during the next hour and began meandering over several square kilometers during that time. I lost her signal from 1410 to 1450 and when I located her again she was moving east-southeast, paralleling the Wisconsin River. She moved 22.5 km in this direction and again began wandering from 1700 to 1800. Her wandering flight was low and slow and limited to low marshy areas. By 1858 she was confining her movements to a small (about 4 ha) marsh and by 1916 she was inactive. She did not fly during the next 20 min and the signal indicated that she was totally inactive and probably asleep. This roost (roost 2, Fig. 2) was 71 km from the previous night's roost although she travelled much farther during the day.

The next morning, 15 August, F2 was already active by 0434, but was still on the ground where I left her the night before. She did not leave the roost until 0455 and then flew only briefly. There was a moderate ground fog which began lifting about 0600 and at 0612 F2 began hunting. She spent the rest of the morning hunting and perching within 1.6 km of the roost. The wind switched to the south and by 1100 it was blowing 10–19 km/hr. At 1240 I lost the radio signal. She had drifted downwind, and because she moved straight away from me, I had not been able to detect the movement. About 1800 I picked up the signal in another marsh 19.3 km north of where I lost her. By 1923 I located her roosting in the new marsh (roost 3, Fig. 2).

It rained during the night and the next morning was overcast and calm with a slight mist. At 0552 the bird was near her roost and fairly inactive. The weather started to clear and at 0612 she began hunting. She spent the next 3 hrs coursing the marsh. A northwest wind came up and by 0945 it was blowing 16–32 km/hr. F2 began circling up at 0950. She moved slowly to the southeast for about 9.7 km during the next 2 hrs. At 1201 she started soaring with 2 other harriers and all 3 started drifting quickly to the south-southeast. F2 continued to move south-southeast for another 29 km. Her flight was fast and direct. I began to lose her signal at 1405 and after 1415 lost it completely. It was 1800 before I located the signal with an aircraft 68 km southeast of where I lost her in the afternoon. By dark I pinpointed her roosting location 106 km from the previous night's roost (roost 4, Fig. 2).

The next morning, 17 August, F2 began hunting at 0520 and spent the rest of the day hunting, perching, and soaring within 3.2 km of the roost. Even though it was a perfect migration day with strong northwesterly winds, she made no long moves. She was inactive by 1915 and roosted about 137 m south of her roost of the night before.

I followed F2 from dawn until dark for the next 3 days, 18–20 August, and she made no large moves (see Fig. 3). She continued to use the same roost and hunt the same areas. She made 2 short exploratory flights away from the roost site, but returned to her temporary home range within 3 hours. The area of her temporary home range was 6 km². She was now 164 km from her nest. After she roosted on 20 August I returned to the Buena Vista Marsh to check the other radio-tagged young.

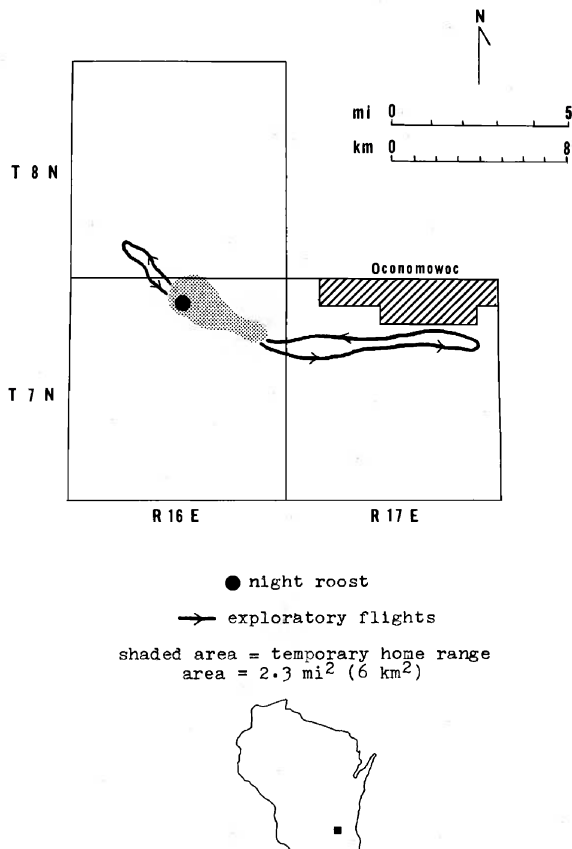


Figure 3.—Temporary home range, roost site, and exploratory flights of juvenile F2, 16–20 August. She was still present on 22 and 29 August 1977.

I flew transects east of the Buena Vista Marsh to Lake Michigan and south of the study area to the Illinois-Wisconsin border on 22 August (Fig. 4). I located F2 where I left her on 20 August. She was in the same place again on 29 August, and had apparently been there for 13 days.

On 9 and 11 September I searched the marsh and the surrounding 15.5 km² area, but could not locate F2. Apparently she left between 30 August and 9 September.

I was unable to fly search transects from 13 to 24 September. On 25 and 26 September I searched the southeast quarter of the state again (Fig. 4), but did not find F2. I never picked up her signal again.

Case history of M1: M1 was the first young to leave the study area. He left sometime after 0830 on 11 August, 2 days before F2. I had no contact with M1 until 22 August, when I found him 85 km east-southeast of his nest (temporary home range A, Fig. 2). I located him nearby from the air at 1500 on 23 August, and again at 0515 on 24 August. I followed him by car until he went to roost that day, and from dawn to dark the next day. He remained within 5.6 km of his roost during those 2 days, except for one afternoon exploratory flight of 27 km south and back (Fig. 5). The area of this temporary home range was 19.4 km².

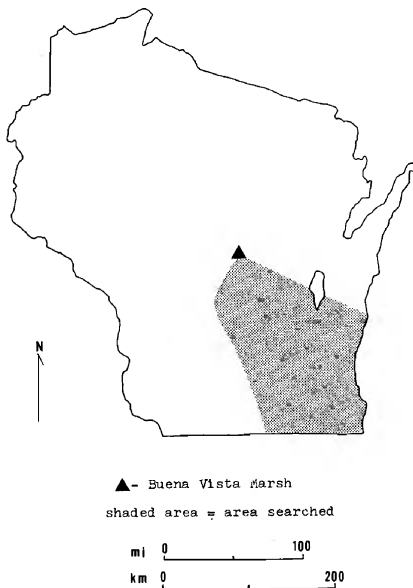


Figure 4.—Area of Wisconsin searched for radio-tagged juvenile harriers on 22 and 29 August, 25 and 26 September 1977 and 17 May 1978.

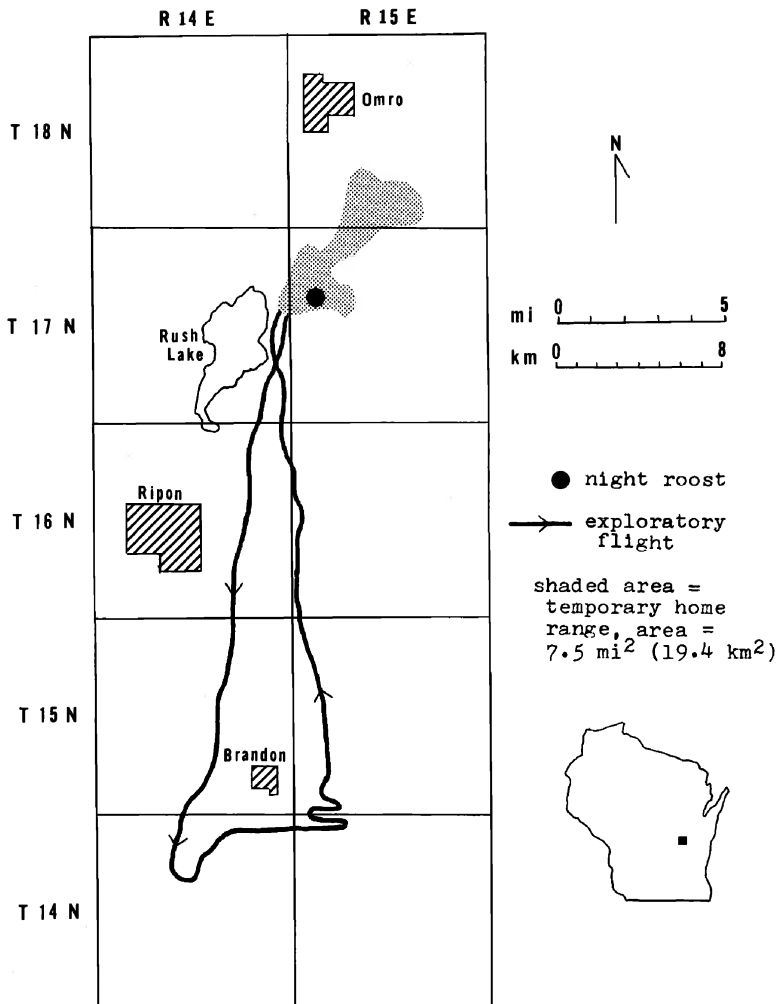


Figure 5.—Temporary home range A, roost site, and exploratory flight of juvenile M1: 22–25, 29–30 August and 9 and 11 September 1977.

M1 was in the same marsh on 29 August and in his usual roost that evening; he remained in that marsh during the next morning. He was near his roost late in the day on both 9 and 11 September, even though 10 September had been an excellent migration day. At this point, he apparently had been using the same marsh for at least 21 days.

On 26 September I found him 109 km to the south-southeast. He was now 171 km southeast of his nest 46 days after leaving the nest area (temporary home range B, Fig. 2). On 28 September I located him just before dark near his location of 26 September. I tracked him in this temporary home range through 30 September and again from 18 through 21 October; he made no permanent moves during this time (Fig. 6). His movements in temporary home range B covered an area of 80 km². I searched this and adjacent areas for M1, from the ground, on 10 November but I was unable to find him.

My last contact with M1 was on 21 October, 64 days after he left the nest area. His dispersal had been interrupted by stopovers at 2 areas. The first 85 km from his nest and was used for at least 21 days; the second, at 171 km, was used for at least 25 days.

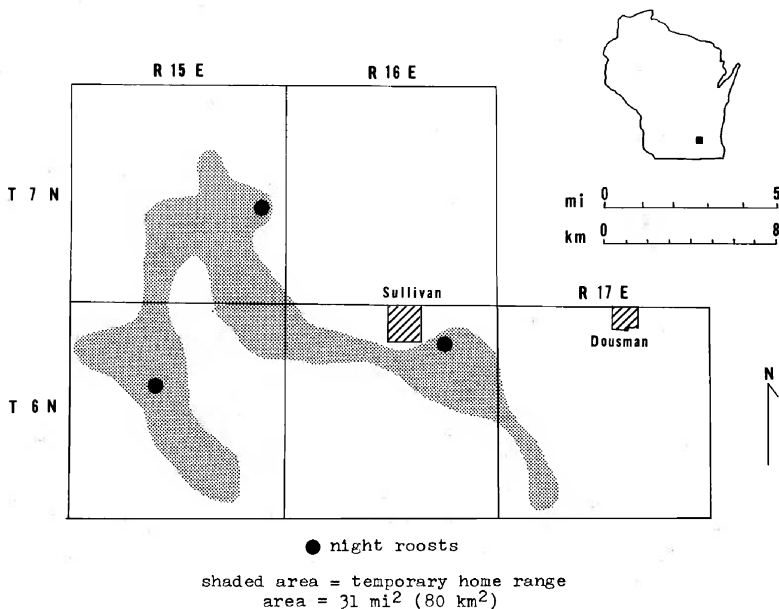


Figure 6.—Temporary home range B and roost sites of juvenile M1: 26, 28–30 September and 18–21 October 1977.

Case history of F1: F1 left the study area on southwesterly winds on 12 August. While I was watching her she suddenly, at 0930, flew east from the area in which she had spent the past 3 weeks. This move should have alerted me that she was leaving. I watched her fly out of sight and did not find her again until I flew transects over the southeast quarter of the state on 22 August (Fig. 4). This location (Fig. 2) was not precise. It is the only location I have for her off the study area, even though I searched the southeast quarter of the state again on 29 August and 25–26 September. F1 was about 71 km southeast of her nest 10 days after leaving the nest area.

On 17 May 1978 I flew transects over the southeast quarter of Wisconsin. This area included all known locations of the juveniles after they left the Buena Vista Marsh. Very few harriers, banded as young, have ever returned to the study area (Hamerstrom 1969). I was curious to see if my radio-tagged birds might have returned to the marshes in which they had spent so much time during autumn stopovers, but failed to find them.

Discussion

Local Movements

All of the juveniles remained close to the nest and to their siblings before dispersing. The first week after fledging I never found them more than 91 m from their nest. As they grew stronger on the wing this distance increased to a maximum of 1.4 km at one nest, but the area used did not change after the 2nd week after fledging. The movements around the nest were not random. Although I detect no difference in habitat between used and unused areas, they consistently favored the same area (Fig. 1). Availability of suitable perches (fenceposts and shrubs) may have influenced their local movements.

One might well assume that most local movements of young is associated with learning to hunt. It is possible that they did some hunting before they dispersed, but I saw no evidence except for the one unsuccessful chase in 1976. I saw all the young pouncing on what appeared to be inanimate objects, but this mock hunting never had the intensity that hunting adults display. The young occasionally appeared to be truly hunting and suddenly dived at something, only to fly up with a clump of grass or some other inedible "quarry". These incidents may have been unsuccessful attempts at catching prey, but I suspect they were merely play.

I saw no evidence that adults taught the young to hunt, even by example. Most hunting by adults was not in sight of the young.

Although it seems unlikely that the young would leave their natal area and food supply (their parents) before hunting successfully, this definitely appeared to be the case. K. L. Bildstein (pers. comm.) observed the same lack of hunting by over 20 juveniles at 8 nests he studied in 1977 and 1979.

The adults were still present at both nests in 1977 when the first 3 young dispersed and at least 3 of the adults remained on the study area until after all the young were gone. I saw no suggestion of adults driving away young.

Migratory Movements

Permanent moves: The only permanent moves I actually followed were those of F2 from 13 August to 16 August. These moves were characterized by alternating periods of high soaring or gliding and lower level flapping. Gliding tended to be fast and direct

with little circling or doubling back. From a vehicle confined to roads, it was difficult to estimate ground speed of a harrier soaring and gliding cross country with a tail wind. I estimated the ground speed to average 64 km/hr while gliding fast. Lower level flapping flight speed, 9–30 m above the ground, was easier to estimate because F2 often paralleled a road; it averaged 40–48 km/hr. Occasionally F2 dropped even lower, to within 1 m of the ground, to perch or hunt briefly before regaining height and continuing on. These lulls in travel lasted from 15 to 60 min and included wandering that departed from the main direction of flight. All permanent moves were primarily downwind but deviated slightly to follow drainages and marshes. F2 moved mostly alone although on one afternoon she joined two other unmarked immature harriers and all 3 soared and glided together for the next 19 km until I lost sight of them 1.5 h later. On several other occasions F2 encountered harriers or other raptors and moved with them for periods of 5–15 min.

Permanent moves started after 0830 (except on 14 August when F2 began moving at 0503) and ended 1–2 hrs before sunset. Mueller and Berger (1973) observed 78% of the harriers passing Cedar Grove, Wisconsin between 0800 and 1400. I have no evidence that the birds ever moved at night. Every time I located a radio-tagged harrier in a night roost (N=9) it was still in the same location the following morning.

Exploratory flights: I followed F2 on 2 exploratory flights from temporary home range 4 (Fig. 3) and M1 on 1 exploratory flight from temporary home range A (Fig. 5). Like the permanent moves, exploratory flights took place after 0830 and ended at least 1 hr before sunset. They were initiated after the bird had fed within the temporary home range and were preceded by 1 or more stationary soaring flights as if they were testing the winds aloft. Both birds characteristically moved downwind from their temporary home ranges and returned into the wind. Exploratory flights seemed to end when the bird reached unsuitable habitat. In one case F2 turned back when she reached the edge of a large residential area. In 2 other cases, 1 each with F2 and M1, they turned back when reaching intensively farmed areas. These explorations tended to be fairly direct and slow with little soaring. On returning, the birds always retraced or paralleled their outgoing route as though following visual cues. Persistent hunting was not characteristic during exploratory flights and I saw no prey taken, even though they tended to follow suitable hunting habitat. The radio-tagged birds moved alone during these flights.

Movements within temporary home ranges: When F2 reached roost 4 (Fig. 2) on 16 August I expected her to continue migrating the next day. Instead, except for exploratory flights, she spent the next 4 days in the same area (Fig. 3) even though the weather was good for migration on 2 of those days. She covered the entire temporary home range many times during a day.

M1's temporary home ranges are illustrated in Figures 5 and 6. His daily movements and temporary home ranges were much larger than those of F2. This may have been a sexual difference, individual variation, or difference in quality of habitat.

Night roosts: Before the radio-tagged young left the study area they roosted within 0.8 km of their nests and often roosted within 18 m of siblings. The same roost area was used almost exclusively at each nest. This habit of roosting repeatedly in the same area was resumed on temporary home ranges. F2 used roost 4 for 5 consecutive nights. Al-

though I could not determine if the exact spot was used, all roosts were within a 137 m diameter circle. M1 also used the same roost for at least 5 nights in temporary home range A. By the time M1 reached temporary home range B, however, his pattern changed. He tended to pick widely separated (9.7 km apart) night roosts. Although communal winter roosts of harriers are not uncommon (Bildstein 1979, Brown and Amadon 1968, Weller et al. 1955), I never found radio-tagged young roosting communally: too early in the season, perhaps? In fact, when other harriers were nearby in late afternoon they all moved off separately in different directions as sunset approached.

Hunting behavior during migration: The area around roosts was consistently good for hunting. F2 regularly hunted near her roosts, not only near the 1-night roosts during her permanent moves, but also for 4 days near roost 4 in her temporary home range. Although F2 hunted throughout her home range, the most intensive, successful hunting was concentrated near the roost. M1 also did most successful hunting near his roost in temporary home range A, but by the time he reached temporary home range B this relationship broke down and he flew as far as 13 km from his roost before hunting.

Surprisingly, the young seemed to be easily able to find enough to eat, although I had not seen any of the young take prey before they left the nest area. Both F2 and M1 spent several hours each day loafing, preening and playing. Although it is often difficult to distinguish how seriously a bird is hunting, when they did seem intent on hunting they killed within 15–60 min. Most prey that I saw taken were small mammals, probably *Microtus* spp. F2 also pursued a Common Snipe (*Capella gallinago*) unsuccessfully and struck a female Ring-necked Pheasant (*Phasianus colchicus*) without killing it. M2 killed an adult male Red-winged Blackbird (*Agelaius phoeniceus*) and occasionally chased other small passerines, but his other 12 identified kills were small mammals. Although I observed occasional intensive hunting at all times of day, hunting consistently occurred about 1 hr after sunrise and again 1 or 2 hrs before sunset.

Direction of movements: The radio-tagged young moved southeasterly as did 9 of 12 banded harriers hatched on the Buena Vista Marsh and recovered in their first fall and winter (Fig. 7, F. Hamerstrom, pers. comm.).

The dates of Hamerstrom's band recoveries suggest the movement is slow, similar to the movements of my radio-tagged birds. Evidence that harrier migration continues throughout the entire autumn is given by Mueller and Berger (1961).

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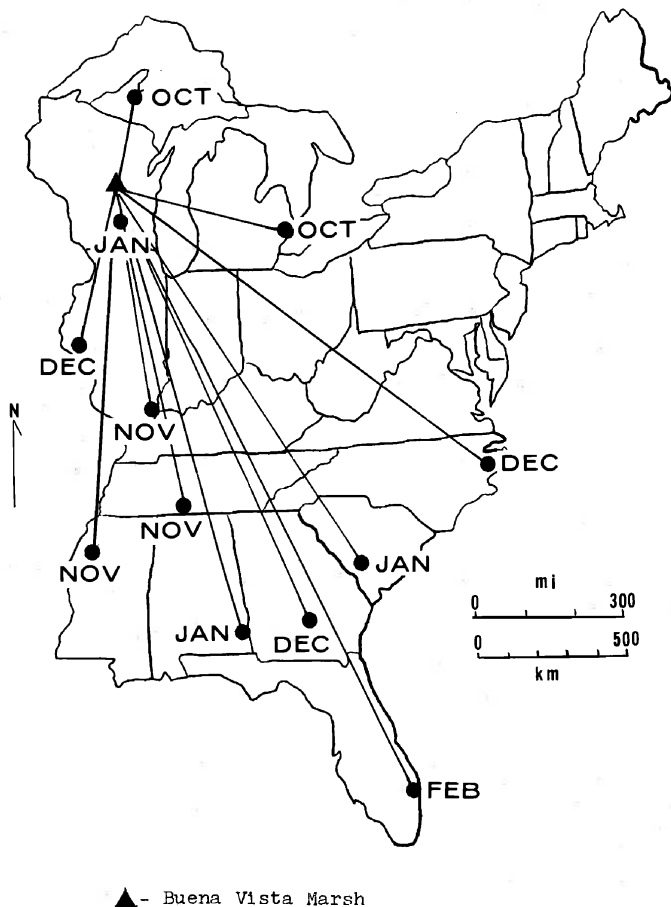


Figure 7.—Banding recoveries of nestling harriers from Buena Vista Marsh during their first fall and winter of life, 1959–1977.

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